REMARKS

In the Office Action, claims 8, 10-14 and 16-26 are rejected under 35 U.S.C. §112, first paragraph; claims 8, 10-14, and 16-26 have been rejected under 35 U.S.C. §103. Claims 8, 14 and 21 have been amended. Applicants believe the rejections have been overcome as set forth below.

Regarding the §112 rejection and the objection to the Specification, Applicants have amended claims 8, 14 and 21 to recite, at least in part, a fuel cell wherein at least one of a first electrode and a second electrode comprises a thickness ranging from about 2 μm to about 4 μm. As pointed out by the Patent Office, the specification is enabling for a fuel electrode (or an oxygen electrode) with a range of about 2 to about 4 *μm*. See, Office Action, page 2. Furthermore, on page 7, lines 31-32 of the specification, Applicants have provided a prophetic working example that the fuel electrode 2 and the oxygen electrode 3 "may be of an extremely thin thickness of, for example, ranging from about 2 to about 4 *μm*."

Accordingly, Applicants respectfully request that the rejection under 35 U.S.C. §112, first paragraph, and the objection to the Specification be withdrawn.

In the Office Action, claims 8, 10-14, and 16-32 are rejected under 35 U.S.C. §103. More specifically, claims 8, 10, 14, 16-18, 20, 21 and 26 are rejected in view of U.S. Patent No. 6,589,682 to Fleckner et al. ("*Fleckner*") as evidenced by U.S. Patent Application No. 2003/0048057 to Oyama et al. ("*Oyama*"); claims 8, 11, 14, 16, 21 and 23 are rejected in view of U.S. Patent No. 6,013,371 to Hager et al. ("Hager") in view of U.S. Patent No. 5,861,222 to Fischer et al. ("*Fischer*") as evidenced by Kordesch et al. ("*Kordesch*"); and claims 12, 13, 19, 22, 24 and 25 are rejected in view of *Fleckner* in view of *Hager*. Applicants believe that the obviousness rejections are improper or have been overcome for at least the reasons detailed below.

At the outset, the Patent Office primarily relies on *Fleckner* or *Hager* in support of the obviousness rejections. With respect to *Fleckner*, this reference is clearly distinguishable from the claimed invention.

Of the pending claims at issue, amended claims 8, 14 and 21 are the sole independent claims. Claim 8 recites a gas diffusion electrode operable within a fuel cell that includes a fibrous carbonaceous material wherein the gas diffusion electrode includes a thickness ranging

from about 2 μm to about 4 μm. Claim 14 recites a fuel cell that at least includes a proton conductor disposed between a first electrode and a second electrode wherein at least one of the first electrode and the second electrode includes a fibrous carbonaceous material that is formed on the proton conductor and wherein at least one of the first electrode and the second electrode includes a thickness ranging from about 2 μm to about 4 μm. Claim 21 recites a fuel cell that includes, in part, at least one of a first electrode and a second electrode that includes a carbonaceous material wherein at least one of the first electrode and the second electrode includes a thickness ranging from about 2 μm to about 4 μm.

According to the present invention, the fibrous carbonaceous material can be directly formed on the proton conductor. In this regard, it is not necessary to separately handle the fuel electrode and/or the oxygen electrode and thus the mechanical strength of the electrodes does not have to be taken into consideration. Therefore, the electrodes may be reduced in thickness. This can enhance the cell reaction and improve cell performance. See, Specification, p. 2, lines 19-26.

Applicants believe that *Fleckner* is deficient with respect to the claimed invention for at least a number of reasons. *Fleckner* fails to even mention the thickness requirements of the alleged gas diffusion electrode (100, 102) as even admitted by the Patent Office. See, Office Action, page 4. Indeed, Applicants have discovered that the fuel electrode and oxygen electrode are not required to be independent films, and thus, are not required to exhibit mechanical strength. In this regard, the thickness of the electrodes can be extremely thin, such as from about 2 μm to about 4 μm. In contrast, *Fleckner* emphasizes the need for the GDL to exhibit improved mechanical strength. *Fleckner* notes that "one of the advantages of using fullerenes to deliver fuel and oxidizer to the catalytic electrodes of the [alleged] novel fuel cells disclosed herein is that of greater structural rigidity." See, *Fleckner*, col. 6, lines 60-64. *Fleckner* goes on to say that the GDLs are susceptible to crushing, and that the aligned nature of the nanotubes helps prevent crushing. See, *Fleckner*, col. 7, lines 5-7. Therefore, *Fleckner* teaches away from the desirability of creating ultra thin GDL layers because they are susceptible to crushing and require increased structural rigidity. Simply because *Fleckner* discloses that the length of the nanotubes is controllable does not imply or suggest the desirability of an extremely thin GDL. Therefore, it

would not be obvious, to one skilled in the art to make an extremely thin GDL layer, such as one ranging from about 2 μm to about 4 μm.

Furthermore, *Fleckner* does not disclose or suggest that the gas diffusion electrode composed of a carbonaceous material, such as a fibrous carbonaceous material, can be directly formed on the proton conductor material, such as an electrolyte film. In contrast, *Fleckner* discloses a catalytic electrode layer that is sandwiched between the GDL and the proton conductor. See, *Fleckner*, col. 5, lines 57-66. *Fleckner* lists additional ways in which the GDL may be formed, none of which suggest applying the nanotubes to the proton conductor. For example, one disclosed method of forming the GDL provides that aligned arrays of fullerenes can be adhered to the surfaces of the flow field plate (FFP). See, *Fleckner*, column 6, lines 53-56. Alternatively, the GDLs can be fabricated by affixing the nanotubes to a conventional, porous GDL material such as Teflon-impregnated carbon paper, an aerogel, or a carbon fibermat. See, *Fleckner*, col. 7, lines 1-5. Nowhere does *Fleckner* suggest that the GDL may be formed on the proton conductor.

Again, Applicants have advantageously discovered that the fibrous carbonaceous material can be directly formed as one or both of the fuel and oxygen electrodes on the proton conductor, and thus, separate handling of the fuel and/or oxygen electrodes is not required. Moreover, Applicants have demonstrated that a fuel cell that incorporates the electrodes has a superior performance, such as an output of approximately 100 mW, 0.6 V, and further can be more easily manufactured by forming the fuel and/or oxygen electrode directly on the proton conductor. See, Specification, page 7, line 29 to page 8, line 5. Thus, Applicants believe that *Fleckner* is clearly distinguishable from the claimed invention for at least these reasons.

Further, Applicants do not believe that the remaining cited art relied on by the Patent Office in support of *Fleckner* can be utilized to remedy the deficiencies of same. With regard to the §103 rejection of claims 8, 10, 14, 16-18, 20, 21 and 26, assuming arguendo that *Oyama* can even be asserted as prior art, which Applicants question, the Patent Office merely relies on *Oyama* for its alleged teaching regarding a fibrous carbon material. See, Office Action, page 4. Therefore, even if properly combinable, *Fleckner* and *Oyama* do not disclose or suggest a fuel cell that includes a fibrous carbonaceous material wherein the gas diffusion electrode includes a thickness ranging from about 2 μm to about 4 μm.

With regard to the §103 rejection of claims 12, 13, 19, 22, 24 and 25, the Patent Office has relied on *Hager* to remedy the deficiencies of *Fleckner*. The Patent Office merely relies on *Hager* for the teachings of same as they purportedly relate to carbon fibers enhancing the mechanical performance of a carbon-carbon composite. As even admitted by the Patent Office, the *Hager* reference fails to provide the thickness of the gas diffusion electrode for use in a fuel cell. See, Office Action, p. 4. As previously discussed, independent claims 8, 14 and 21 have been amended to recite, in part, that the electrode has a thickness ranging from about 2 μm to about 4 μm. Therefore, *Hager* fails to remedy the deficiencies of *Fleckner*.

As discussed above, the Patent Office has primarily relied on *Hager* in support of the obviousness rejection with respect to claims 8, 11, 14, 16, 21 and 23. Applicants submit that *Fischer* and *Kordesch* can not be relied on solely to remedy the deficiencies of *Hager*. As stated above, the *Hager* reference at a minimumfails to provide the thickness of the gas diffusion electrode for use in a fuel cell.

In *Fischer*, the electrode includes a proton-conducting polymer membrane with an electro-catalyst dispersed therein. See, *Fischer*, column 4, lines 32-39. Indeed, the preferred proton connecting polymer includes a fluorocarbon vinyl ether polymer (see, *Fischer*, column 4, lines 40-42), and further discloses that at a thickness of less than 5 μm, the electrode becomes increasingly less cohesive due to its high porosity (see *Fischer*, column 5, lines 56-58). Clearly, this suggests that *Fischer* is distinguishable from the claimed invention to the extent that it effectively teaches away from the claimed invention that recites, in part, a gas diffusion electrode within a fuel cell that has a thickness ranging from about 2 μm to about 4 μm. Moreover, the Patent Office merely relies on *Kordesch* for its alleged teaching that a proton conducting material is sandwiched between an anode and a cathode in a fuel cell. See, Office Action, page 6. Therefore, even if combinable, *Fischer* and *Kordesch* do not teach or suggest a fuel cell that includes a fibrous carbonaceous material wherein the gas diffusion electrode includes a thickness ranging from about 2 μm to about 4 μm.

In addition, Applicants respectfully submit that the Patent Office has relied on hindsight reconstruction of the claimed invention, thus using the claimed invention as a template for reconstruction thereof. Indeed, the Patent Office attempts to modify the teachings of *Fleckner* or *Fischer* in combination with other references, where both *Fleckner* and *Fischer* teach away from

a gas diffusion electrode including a fibrous carbonaceous material, wherein the thickness of the electrode ranges from about 2 μm to about 4 μm as claimed and discussed above.

In one example, the Patent Office bases the combination of *Fischer* and *Hager* on their alleged common teaching regarding a gas diffusion electrode. The Patent Office suggests that the person skilled in the art of manufacturing nanotube based fuel cell electrodes as suggested in *Hager*, would look to *Fischer* to determine the optimal thickness of the nanotube electrode. As compared to nanotubes, the electrodes in *Fischer* are composed of a completely different chemical and physical composition with dimensional stability limited by its porosity. See, *Fischer*, col. 5, lines 56-60. Indeed, *Fischer* teaches a gas diffusion electrode containing an electrocatalyst which is dispersed in a proton conducting isomer and which has a porosity between 40 and 75%. *Fischer* speaks of an optimal electrode thickness that is based on this particular composition. Thus, the experimental data, and the like from *Fischer* fails to provide any guidance to modify *Hager*. For this reason, and for at least the reasons discussed above, one skilled in the art would not be motivated to modify the cited art to purportedly reconstruct the claimed invention.

Based on at least those reasons above, Applicants believe that the cited art, even if properly combinable, is distinguishable with respect to the claimed invention.

Accordingly, Applicants respectfully request that the obviousness rejections with respect to claims 8, 10-14 and 16-26 be withdrawn.

For the foregoing reasons, Applicants believe that the present application is in condition for allowance and earnestly solicit reconsideration of same.

Respectfully submitted,

BELL, BOYD & LLOYD LLC

BY ______________________

Thomas C. Basso
Reg. No. 46,541
P.O. Box 1135
Chicago, Illinois 60690-1135
Phone: (312) 807-4310

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